

Steps Toward End-to-End Personalized AAL Services

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Abstract. In Ambient Assisted Living research and development, a significant effort has been dedicated to issues like gathering continuous information at home, standardizing formats in order to create environments more easily, extracting further information from raw data using different techniques to reconstruct context. An aspect relatively less developed but also important is the design of personalized end-to-end services for technology users being them either primary (older people) or secondary (medical doctors, caregiver, relatives). This paper explores an effort, internal to the EU project GIRAFFPLUS, for designing such services starting from a state-of-the-art continuous data gathering infrastructure. The paper presents the general project idea, the current choices for the middleware infrastructure and the pursued direction for a set of services personalized to different classes of users.

Keywords. Ambient Assisted Living, Personalized Interactive Services, Long-term Data Monitoring, Older People Support.

Introduction

In recent years there is an increasing attention of the topic of “prolonging independent living”. Several initiatives all over the world have focused attention on the problem of the aging population (see [16] and many others) and funding programs have been triggered like the Ambient Assisted Living (AAL), promoted by the European Commission in the FP7 research areas, more specifically, in the “AAL Joint Program”. The general aim is the one of promoting a healthier society constituting a main social and economic challenge. In fact, most elderly people aim at remaining in their homes as long as possible as this is in general conducive of a richer social life and paramount to maintaining established habits. To adhere to this wish is also positive from an economic perspective as the cost of care at home is almost always much less than the cost of residential care.

Several issues need to be addressed in order to prolong independent living. One is early detection of possible deterioration of health so that problems can be remediated in an early stage and timely involvement of health care providers and family can be assured. A second issue is to provide adaptive support which can offer services to assist in coping with age-related impairments. Third, ways of supporting preventive medicine must be

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found as it has been increasingly recognized that preventive medicine can contribute to promoting a healthy lifestyle and delay the onset of age-related illnesses. Observing the current efforts in the AAL projects, and the trends in the “internet of things” [12,3], an amount of R&D effort exists on issues like the gathering of continuous information at home, the standardization of formats in order to create environments more easily, the extraction of further information from raw data using different techniques to reconstruct context, etc. This paper aims to underscore one further aspect for research in the area: the need for personalizing services starting from the data and arriving to serve real needs of users. In particular elaborating on current work in an EU project called GIRAFFPLUS we will underscore the relevance of producing a comprehensive approach toward end-users.

Plan of the Paper. The paper first discusses additional motivations and related work in Section 1 then introduces the GIRAFFPLUS project broad idea in Section 2. Section 3 describes the system architecture and the basic data support services, while Section 4 presents the interactive and personalization services, trying to demonstrate how such services create a needed glue for adapting the technology to the users. A concluding section ends the paper.

1. Motivations and Context

Evolving access to information and to computing resources into an utility is a big target in the current ICT research fields. As stated in [4], the computing facilities of large enterprises are evolving into an utility. This is true for AAL systems especially when integrated with Healthcare Information Systems (HIS), which should become far more portable from one site to another in order to limit development and maintenance costs. Reusing legacy software, developing mediation systems, component-based architectures, or implementing client adaptation through proxies are common situations in this context. This kind of applications use intermediate software that resides on top of the operating systems and communication protocols to perform the following functions: hiding distribution (i.e. the fact that an application is usually made up of many interconnected parts running in distributed locations), hiding heterogeneity (i.e. various hardware components, operating systems and communication protocols that are used by the different parts of an application), providing uniform and standard high-level interfaces (so that applications can easily interoperate and be reused, ported, and composed), supplying a set of common services to perform various general purpose functions, in order to avoid duplicating efforts and to facilitate collaboration between applications. This intermediate software layer have come to be known under the generic name of middleware. Using middleware has many benefits, most of which derive from abstraction: hiding low-level details, providing language and platform independence, reusing expertise and possibly code, easing application evolution. As a consequence, the application development cost is reduced, while quality (since most efforts may be devoted to application specific problems), portability and interoperability are increased [10].

The current effort in the GIRAFFPLUS project is in designing and implementing personalized services for end users on top of a state-of-the-art continuous data-gathering infrastructure. The GIRAFFPLUS project aims to develop and evaluate a complete system able to collect elderlys daily behavior and physiological measures from distributed sensors in living environments as well as to organize the gathered information so as to provide customizable visualization and monitoring services for both primary and secondary users. In this regard, a Data Visualization, Personalization and Interaction Service (DVPIS) has been realized to manage interaction with the different actors in such

AAL scenario. In particular, two different instances of the DVPIS have been provided: one for use “outside the home” (DVPIS@Office), and another dedicated to the primary user (DVPIS@Home). The benefit pursued by the GIRAFFPLUS system is twofold: primary users can access the information on their own health condition, enabling them to better manage their health and lifestyle; secondary users are supported by a flexible and efficient monitoring tool while taking care of old persons (relatives/patients).

Related Projects. As said before, the European Commission is promoting many different research initiatives on Ambient Intelligence, particularly focusing on multi-sensorial environments and distributed ICT services. Among others, the UNIVERSAAL [18] project can be considered the major representative of such effort. In fact, it is an FP7 project aiming to standardize an open platform and reference specification for AAL. In particular, UNIVERSAAL is working to the consolidation of other relevant projects results like SOPRANO [17], MPOWER [13], PERSONA [19], OASIS [15], VAALID [2], AALIANCE [1]. Furthermore, projects have focused their efforts in generating more specific AAL technologies. For instance, the telepresence robot called Giraff is currently under evaluation in the ExCITE project [5] while high-level automated reasoning services for supporting end users have been proposed, e.g., in RoboCare [6] and PEIS [14], constituting a relevant example of research initiatives whose main objective is to infer semantic information from raw sensorial data collected in ambient intelligence environments. All the above research activities provide a technological context as a building block for the GIRAFFPLUS project.

2. The GIRAFFPLUS General Idea

The GIRAFFPLUS project’s (<http://www.giraffplus.eu/>) focal points are the following:

- to develop and thoroughly evaluate a complete system able to collect elderly people’s daily behavior and physiological measures from distributed sensors, to perform context recognition and long-term trend analysis;
- to organize the gathered information so as to provide customizable visualization and monitoring services for caregivers;
- to foster social interaction between primary users (elderly) and secondary users (formal and informal caregivers). In broad terms, secondary users can virtually enter the home for a visit or to respond to an event generated by the system, while primary users can request a virtual visit at any time.

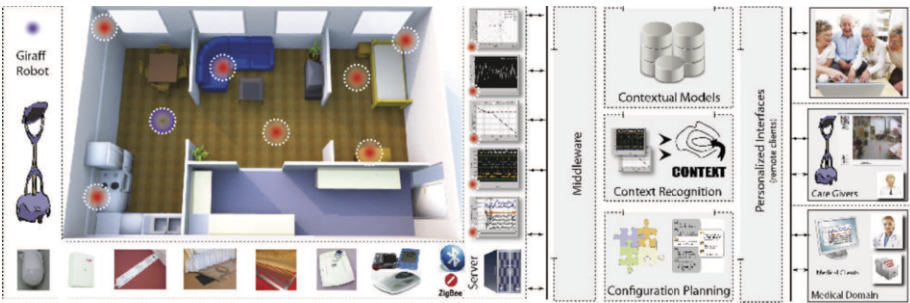


Figure 1. The GIRAFFPLUS complete idea.

The Figure 1 graphically illustrates the main components of the system (described in detail in [7]). The GIRAFFPLUS system includes a network of sensors (red dots in the figure) constituted by both physiological as well as environmental sensors that measure both the physical status of the primary user, e.g. the blood pressure, and detect the environmental condition of the home living environment, e.g. whether somebody occupies a chair, falls down or moves inside a room. The data from these sensors are interpreted by an intelligent system (called the Context Recognition), in terms of activities, health and wellbeing: e.g. the person is exercising or the person is going to bed, or a fall has occurred. Then, these activities can also trigger alarms or reminders to the primary user or his/her caregivers, or be analyzed off line and over time by a healthcare professional. The system should automatically adapt to perform specific services such as checking the persons night activities. Personalized interfaces for primary and secondary users are developed to access and analyze the information from the context recognition system for different purposes and over different time scales. An important feature of the system is an infrastructure (the Configuration Planning) for adding and removing new sensors seamlessly and to automatically configure the system for different services given the available sensors. The above features provide an adaptive support which facilitates timely involvement of caregivers and allows monitoring relevant parameters only when needed. There is also a telepresence robot, called Giraff, which can be moved around in the home by somebody connected to it over Internet, e.g. a caregiver. The Giraff robot is a mobile communication platform, equipped with video camera, display, microphone and speakers, and a touch screen. It helps the user to maintain his/her social contacts.

Secondary users of the systems are family, friends, informal and formal care givers and health professionals. They access the system via a PC. We envision two main kinds of secondary users of the system: relatives/friends that connect with the Giraff robot and medical personnel that examine trends of collected data. The first kind of users, besides the ability to communicate with the Giraff robot, can also see significant information about what has happened in the home, for instance activities that the elderly has done and physiological parameters that have been measured. Medical personnel see the information collected off-line and can analyze trends in the data, for instance a decline of physical activities during a longer period of time.

One of the peculiar objective of the project is the design and development of a system capable of allowing the personalization of the secondary users interface as well as the selection of what information is supposed to be monitored in agreement with the primary users. Another additional important feature of the system that we are investigating is to empower the elderly enabling the access to the information elaborated by the system through an interface present in the home. Then, the elderly can have also the possibility to see in that interface which secondary users may access the different kind of information. Finally, the system can also rise alarms and send warnings, for instance, in case of falls or in case of abnormal physiological parameters.

In the project, particular emphasis is also put on user evaluation outside the laboratories. In fact, the GIRAFFPLUS system will be installed and evaluated in 15 homes of elderly people distributed in three European countries, i.e., Italy, Spain and Sweden. In particular, the concept of "usworthiness" is central in order to assure that the GIRAFFPLUS system provides services that are easy and worth using. Then, these evaluations will drive further the development of the system.

3. The GIRAFFPLUS Architecture

This section describes the general architecture of the GIRAFFPLUS system. In particular, we present the specification of the system in terms of components, functionalities and interfaces among components. Also, here it is described how the components are integrated and interfaced with the rest of the system. Figure 2 depicts an abstract component diagram of the GIRAFFPLUS system. In particular, three main components can be identified: (a) the Physical Environment and Software Infrastructure, (b) the Middleware Infrastructure and (c) the Service Layer.

The *Physical Environment and Software Infrastructure* coupled with the *Middleware Infrastructure* (see Fig. 2) represent the basic level of functionalities of the GIRAFFPLUS system. Indeed, all the data services are grounded on the functionalities of this part of the system and these modules that are also in charge of providing the common and interoperable communication service. In particular, the *Middleware Infrastructure*

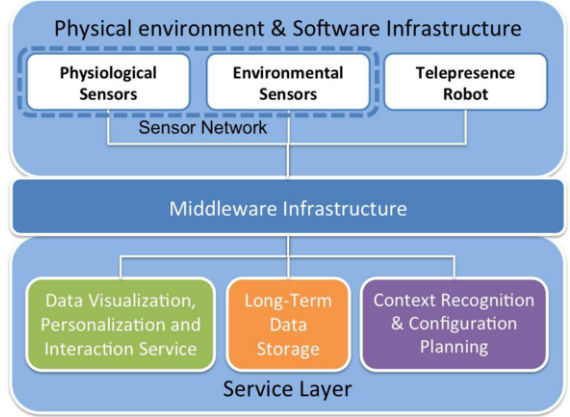


Figure 2.: The GIRAFFPLUS components.

constitutes a gateway shared among all the system components. Then, the *Sensor Network*, composed by both *Physiological and Environmental sensors*, gathers the information generated in the home environment as well as provides the (possibly pre-processed) collected data. Finally, the *Telepresence Robot* provides the GIRAFFPLUS social interaction functionalities enabling remote access in the environment through a Pilot software embedded in the visualization and interaction services (see Sec. 4). The *Long-Term Data Storage* component (see again Fig. 2) is responsible for providing a general database service for all the data generated by parts of the system and providing data access functionalities. Specifically, the main role of this component is to manage a database containing all the data collected through the *Middleware Infrastructure* and generated by the *Sensors Network* (see section 3.2). The *Context Recognition and Configuration Planning* (bottom-right in Fig. 2) is the component responsible for context/activity recognition and system configuration planning, i.e., two high-level reasoning systems in charge of (respectively) implementing the monitoring activities by means of context/activity recognition [20] and providing suitable configuration settings for the *Sensors Network* according to the requested monitoring activities [11]². Finally, the *Data Visualization, Personalization and Interaction Service* (bottom-left in Fig. 2) is the part of the system responsible for creating user-oriented service. A broad way to summarize the module is to provide different end-users with suitable interaction modalities for the available services. In Section 4, a more thorough presentation of this module is provided.

²The description of the Context Recognition and Configuration Planning components is out of the scope of the present paper. The reader may refer to [7] for further details.

3.1. AAL Middleware for GIRAFFPLUS

In the GIRAFFPLUS system, a crucial role is played by the Middleware Infrastructure as it provides the central connection point that is shared by all the components according to the needed information exchanges. In fact, given the inner context-aware nature of GIRAFFPLUS system, the presence of a pervasive solution that provides any kind of information about the interaction between the user and the surrounding environment become a key aspect for its effectiveness. The sensors, the services, and the components integrated in the GIRAFFPLUS system need a software infrastructure, which is based on a middleware that hides heterogeneity and distribution of the computational resources in the environment. Moreover, the integration of such components is demanding, especially if we consider that the system is composed of different services written in different languages and it may need to be accessible by a number of remote healthcare centers which may use different protocols. To this aim, an AAL middleware solution well suited to the GIRAFFPLUS context is proposed.

The fragmentation in this sector is still high, but there are initiatives working to build converging solutions. Service interoperability is a key point to build an ecosystem of applications that helps the growth of an AAL consumer market. In this regards, several European projects have intensely worked to the definition and standardization of a common platform for AAL, on top of which to develop intelligent software applications for the end users (see the *Related Projects* section). In this regard, the final objective of the GIRAFFPLUS project is to design and develop a system compliant to the results of the most promising research projects in this field, i.e., universAAL [18].

It was the intention of this work to be aligned to the universAAL results, to reuse the Open Source software released by universAAL as much as possible, and to share the use cases based on the teleoperated robot system in order to enrich the universAAL platform with the technological requirements deriving from the GIRAFFPLUS project. The concrete architecture currently selected by universAAL is based on the Java/OSGi platform and it is aligned with the reference platform selected by GIRAFFPLUS.

Middleware Architecture. Within the proposed AAL ecosystem, hardware as well as software components can be able to share their capabilities. In the GIRAFFPLUS space, the proposed platform facilitates the sharing of two types of capabilities: Service (description, discovery and control of components) and Context (data based on shared models). Therefore, connecting components to the platform is equivalent to using the brokerage mechanism of the middleware in these two areas for interacting with other components in the system. The concrete middleware architecture is made up of two layers: a core middleware API layer and a communication layer that includes a publish/subscribe connector and a RESTful connector (Figure 3).

A generic service built upon the middleware can discover which sensors are present in the environment and other services together with their functionalities using methods from the middleware API layer. The underlying layer fulfills these requests exploiting

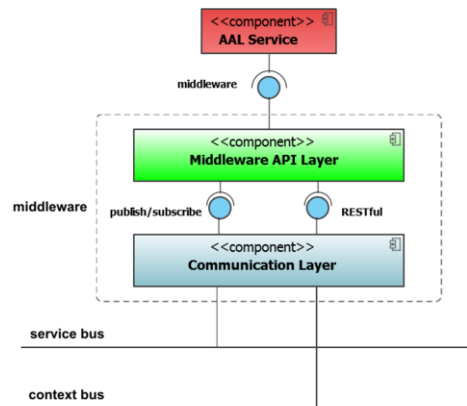


Figure 3. The proposed middleware architecture

the connectors available. In the communication layer, an MQTT [9] and a RESTful [8] connector are present. By mean of these connectors, the middleware realizes a publish/subscribe as well as a methods description/invoke mechanism in a transparent way.

Two buses form the heart of the proposed middleware: a context bus and a service bus. All communications between applications (i.e., the GIRAFFPLUS services) can happen in a round-about way via one of them, even if physically, the applications are located on the same hardware node. Each of the buses handles a specific type of message/request and is realized by different kinds of topics. The aim of the middleware is to provide a publish/subscribe mechanism for accessing the context information about the physical environment and physiological data. This information will be exposed as different topics: topics for discovery and description of devices and services that form the service bus and topics for publishing and retrieving data from devices and services that form the context bus. The middleware is in charge of presenting the available sensors and services in the system implementing an announce mechanism on the service bus. These resources are presented with a message on the relative topic in the service bus. The message is a descriptor file containing an id, a description, a type (i.e exporter or service), a set of resources (i.e. sensors or components), and a set of methods. Once a resource has been announced on the service bus a generic service can search for it filtering on the descriptor fields and use it. The topics used for announce and discovery of devices and service, the so called service bus, has this format

```
<<location>>\serviceBus\<<serviceID>>
```

where `location` identifies, e.g., the room in the assisted persons apartment, `serviceBus` is the keyword to identify the topic as a service bus topic and `serviceID` is the unique identifier of the service. The message of this topic is a JSON descriptor file. The middleware takes care of dispatching information about the state of the resources among services by means of a context bus. Any service that wants to make available his data (sensors readings and events or data analysis results) can use the middleware API to publish it. Any service interested of monitoring these data can subscribe to the relative context bus topics indicated in the descriptor using the middleware API. The topics used for gathering data from devices and service, the so called context bus, has this format:

```
<<location>>\contextBus\<<serviceID>>\<<subtreefield>>
```

where `location` identifies the room, `contextBus` is the keyword to identify the topic as a context bus topic, `serviceID` is the unique identifier of the service and the `subtreefield` identifies all the resources of that service that can be monitored. For each resources there will be a dedicated context bus sub-topic. The message of these topics is a string value.

3.2. Long-Term Data Storage service

The Long-Term Data Storage module aims to provide a central storage for the GIRAFFPLUS system, responsible for storing all the data collected by the Physical Environment, as well as the data produced by other components (High-Level Services). Additionally, it also stores configuration data (sensor data, security restrictions, etc.) and logging data from all the software components in the system (all logs are centrally available, and therefore it is easier to maintain and debug the system). Such service consists of three

connected components: (i) the database, which stores the actual data; (ii) the GIRAFFPLUS Middleware Listener component, which is instantiated in the middleware and forwards all relevant data to the database in a secure fashion; (iii) the RESTful web service, which enables secure access to the database and (iv) the GIRAFFPLUS Middleware Storage component, which enables other GIRAFFPLUS components to directly access the data via the middleware.

The guiding principles in the design of the GIRAFFPLUS Long-Term Data Storage system have been **security**, **flexibility**, **reliability**, **efficiency** and **scalability**. Security is paramount as we are dealing with potentially sensitive information. Flexibility is important as GIRAFFPLUS is a research project and then it is impossible to foresee all the possible data structures that might be stored in the system, as well as all possible connections between them. The storage system needs to be able to reliably store vast amounts of data and enable users and other GIRAFFPLUS components to efficiently access the stored data. Last but not least, the system needs to be scalable as we expect the amount of data to vastly increase during the course of the project and hopefully, during the commercialization phase of the project.

The GIRAFFPLUS database. After a careful examination of available database solutions, we decided to use MongoDB (<http://www.mongodb.org/>), which is a widely used, open source, NoSQL document-oriented database system developed and supported by 10gen (<http://www.10gen.com/>). To follow our guiding principles, we make heavy use of its replication feature, which replicates data over specified groups of servers thereby increasing data reliability, as well as efficiency. We also use the sharding feature, which distributes the data over many replica groups, thereby enabling horizontal scalability and increasing efficiency via load-balancing. Flexibility of the system is achieved due to its NoSQL nature, since the database stores collections of generic JSON (<http://www.json.org/>) objects, which can represent various data-structures that might come up during the lifetime of the project. To increase efficiency we also implemented a database compression method, which compresses collections of data older than a specified date. The method automatically collects data objects coming from the same source and compresses the array of dynamic field values. To retrieve data from compressed collections of object, the method first uncompresses the data and then runs the required filter over them.

The GiraffPlus Middleware Listener component. The GIRAFFPLUS Middleware Listener component is instantiated automatically as the middleware is run. It listens to all data sources connected to the middleware (sensors, other components, logs, *etc.*), properly formats the data, attaches the timestamp and stores the data in the database.

The RESTful GiraffPlus Storage Web Service. The implemented RESTful (Representational State Transfer) web service enables secure (using certificates via SSL) and efficient access to the data stored in the database. It is implemented in Java using Jersey (<https://jersey.java.net/>), which is an open-source, production quality, JAX-RS Reference Implementation for building web services. To run the web service we use the Apache Tomcat (<http://tomcat.apache.org/>), which is an open source software implementation of the Java Servlet and JavaServer Pages technologies and enables easy scalability by using load-balancing between multiple servers.

Data between the web service and its clients is exchanged in JSON format and, if required by the client, compressed to increase the efficiency of data transfer.

The GiraffPlus Middleware Storage component. We predict that at some point during the project there might be multiple Long-term Data Storage centers (LTDC) located in

various locations around Europe (and later on outside Europe) due to possible legal or performance constraints. One of the design goals for the Long-term Data Storage system was to enable partners to write data-location agnostic applications and components. Therefore the only point of contact for each application/component should be the GIRAFFPLUS Middleware and requests for data storage or retrieval should be done via the middleware. For this purpose we implemented a simple Storage component. Its configuration contains the location of the LTDSC to be used for the instantiated middleware and all requests for data storage and retrieval are done through the Storage component, which then forwards requests to the corresponding LTDSC. In this fashion we enable developers to write data-location agnostic applications and components, or, if required, to forward data requests to a specific LTDSC, which contains the requested data.

4. DVPIS: the Data Visualization, Personalization and Interaction Service

The GIRAFFPLUS infrastructure described in the previous section guarantees two very important aspects: (a) the long term storage of sensor data; (b) the possibility of real time connection for information sharing and immediate alarm intervention.³ The work on user-oriented services has started with an analysis of the different type of people that can take advantage of the GIRAFFPLUS services. The basic subdivision between users concerns Primary (the old person in the house) vs. Secondary (different people outside the house). The secondary users can be subdivided in various groups: within GIRAFFPLUS we are particularly interested in services for (1) formal caregivers (e.g., doctors, social workers); (2) informal caregivers (e.g., relatives). A further basic question now is “how can we build useful services for such users?”. One interesting distinction concerns the service time constant we are expecting: (a) long term data analysis, for example, to observe trends for creating regular reports for different users, (b) short term reactive services, like in the case of alarms, to detect emergencies (e.g., fall detection sensors, emergency call buttons, etc.) (c) continuous asynchronous dialogues (e.g., in the case of social network channels, reminding services, etc.) (d) synchronous communication channels for conversations through the telepresence robots.

Figure 4 describes the complete scenario we have realized. Again we underscore different aspects: first of all the double directionality pursued in the complete GIRAFFPLUS service model: (a) Internal vs. External Data Flow: there is a basic direction of data gathering from the house toward the external world (red arrows in the figure). Notice that we distinguish: (1) long term data storage for subsequent analysis and on-demand visualization (red arrow in upper part of the figure), and (2) direct real-time fast connections managed directly through the middleware for alarms (red arrow in lower part); (b) Bidirectional External/Internal communication: this channel allow to support the social interaction services. Initially, the basic telepresence services of the Giraff telepresence robot have been created (www.giraff.com), subsequently the system has been empowered with additional services for increasing support to the primary users (blue arrow in the figure).

The Figure 4 also identify the modules specifically called DVPIS (for Data Visualization, Personalization and Interaction Service) that have been realized to manage interaction with the different actors in an AAL scenario. In particular we have two instances of the DVPIS one for use “outside the house” called DVPIS@Office and another dedi-

³As said before we do not use here the features of the Context Recognition and Configuration Planning module that also aims at creating added value services on top of the basic infrastructure (e.g., enriching the basic gathered data with additional temporal deductions).

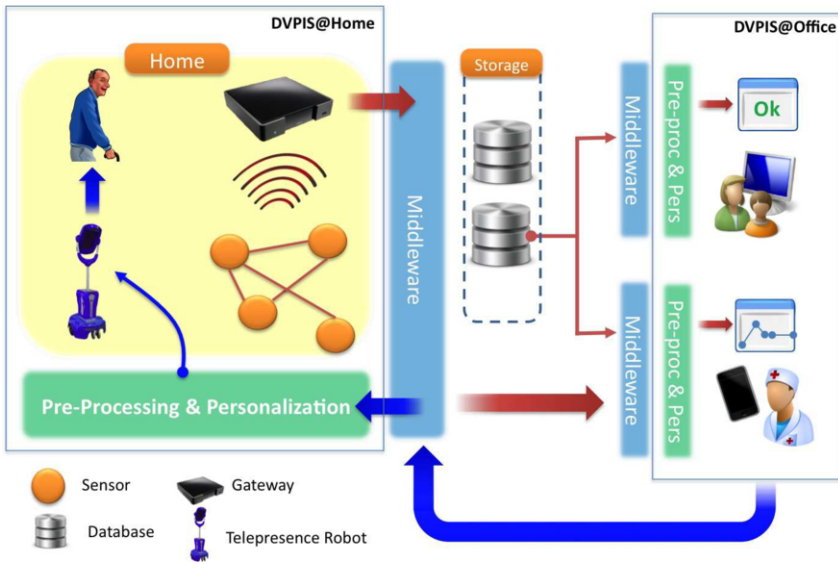


Figure 4. Outside vs. Inside services through DVPIS.

cated to the primary user called DVPIS@Home. Both the DVPIS modules are composed of a front-end which is a visualizer and interaction manager and a back-end that deals with pre-processing of data and personalization of services.

DVPIS@Office. The module dedicated to secondary users strongly rely on querying the data store. Additionally access to the telepresence robot via its external interface is possible within the same comprehensive layout. At present we have designed an interaction front-end that runs on a personal computer but the technological choices allow us to develop also App-style versions for other mobile platforms like tablets or smartphones. Different services are provided for formal and informal caregivers. The personalization for a doctor or a social worker takes into account the fact that this workers may connect to multiple patients at home. Hence there is an environment that manages different houses and help the user to maintain information on the different cases he/she follows. The formal caregiver may access data over time, although specialized the visualization environment allows a combination of queries that are able to generate different graphical views. Figure 5-B presents a test example of the current DVPIS@Office for a doctor observing a week of blood pressure data. Figure 5-A shows a user inspecting a printed report received through the GIRAFFPLUS system and at the same time has decided to query the long term data for observing temporal trends (see the PC screen). The personalization for an informal caregiver (the current target is a relative of the person at home) is far straightforward. Such a person needs a more synthetic information and just report about warning over an interval of time. At present it is possible to ask for daily reports that contain a summary of the informations of the day. We are currently working at producing a scenario similar to the one in Figure 5-A tailored for informal caregivers, with reports that contain a different perspective on the information delivered.

DVPIS@Home. The current front-end in the house for delivering information services is the telepresence robot. In fact, some user requirements gathered during the initial phase of the project suggested to avoid the introduction of further technological objects in the house. In addition, as the Giraff robot is integral part of the project comprehensive design

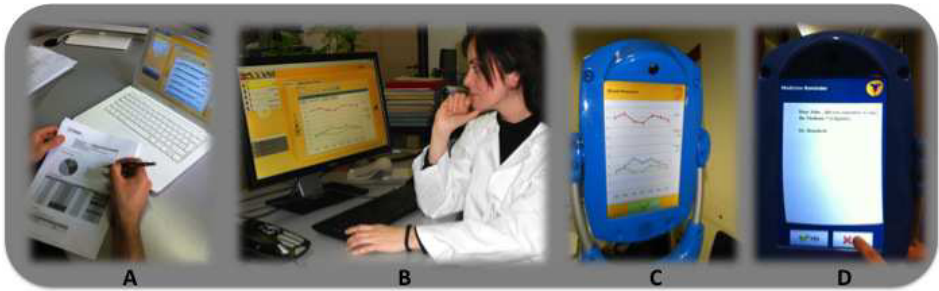


Figure 5. The current DVPIS in operation.

and has a computer on-board for its basic operations, we have decided to exploit it to run the local additional software services. Specifically for the project the company producing the robot has synthesized a touch screen version. The DVPIS@Home is designed to take advantage of this new functionality, somehow the telepresence robot resembles a “tablet on wheels” from the point of view of old people at home. The front end (a) allows to access the standard telepresence services of the robot (b) allows the home users to read simplified reports concerning his/her own health status (c) enable the delivery of asynchronous messages to the user. This last functionality is currently integrated for obtaining a reminding service (a message example is shown in Figure 5-D).

The DVPIS shared dialogue space. The GIRAFFPLUS project is in its second year. Since the first dialogue with potential home users the problem of the dialogue Inside/Outside has been a very important one. For this reason we are endowing the DVPIS of a capability of synchronous communication fully supported by the middleware. Using this functionality we have created a shared information space that allows a dialogue Primary/Secondary user sharing some information on the screen. The current demo of this functionality is shown in the combination of Figure 5-B and -C. It is possible to see that the same information (the weekly blood pressure samples) are in front of the doctor in her office and of the old person at home and they can share also the audio channel for talking. In this way we have set up an environment for flexible end-to-end information delivery on top of an AAL service.

5. Conclusions

This paper presents an ongoing effort to create added value complete services for end users on top of an AAL continuous data gathering environment. It describes the main architectural choices concerning the middleware (UNIVERSAAL compliant), the long-term data storage, and the more abstract component dedicated to interaction and personalization for different users of the AAL environment (the DVPIS module). It is worth underscoring how the interaction services provided by the DVPIS pave the way for creating a complete approach for differentiated users (what can be called an end-to-end service connection to users). The paper contains an initial report on the @Office and @Home services, while an evaluation with users is still on going. Such an evaluation aims at validating the design choices as well as to collect further feedback to be exploited for future iterative design refinements.

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